

IFPS Implementation, Design, and Impact on NWS Field Forecaster Performance
– A Whitepaper submitted by all Western Region SOOs/DOHs
and supported by all Western Region MICs –

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ISSUE: As the National Weather Service moves rapidly into the digital forecast era, an overriding need exists to optimize the mix of human and automated prediction techniques. With the current Interactive Forecast Preparation System (IFPS) implementation, forecasters are being asked to insert mesoscale detail into degraded numerical model output by locally developing and applying simple grid-editing tools. To throw away physically consistent detail from objective model forecasts, only to attempt to restore it with manual intervention, makes little sense and wastes precious human resources. While it is well known that forecasters improve upon model guidance (and MOS) for selected cities, it is still unproven whether the use of these grid-editing tools can improve upon numerical model output beyond these few locations, especially throughout the forecast period of seven days. Currently, it is an even greater challenge given the grids available to the forecasters in GFE are degraded from the full-resolution model grids, which are the logical benchmark when assessing skill. Even the full resolution grids contain model biases and deficiencies that must be addressed within the forecast process. In general, this initial step is best done objectively through statistical post-processing rather than manual editing as is required now. Forecasters can and should play an important role in the grid-editing process (especially in the short term), but they need to be given the best possible starting point in order to get full benefit from their skills and expertise. Unnecessary editing tasks reduce the forecasters' time available to add true value to the grids and pursue excellence in this and other field program areas. In light of ongoing advances in meteorology and technology, the current IFPS design needs to be modified to reduce manual editing requirements through skillful, scientifically-based methods – a path that will result in more accurate forecasts and help reduce inter-site grid discrepancies in the NDFD (National Digital Forecast Database).

RECOMMENDATION: We recognize the need to increase the use of graphical and digital forecasting within the NWS through the implementation of IFPS, and to do so within the current implementation schedule. We also believe it is equally important for the NWS to begin immediately exploring, developing, and implementing new methods and technologies that best ensure the success of IFPS and ultimately the agency. In this whitepaper we recommend, and are eager to participate in, the following set of proposals that will better enable the field to produce detailed and accurate digital forecasts and to allow for the efficient use of human capital.

PROPOSALS

- Develop a national real-time, gridded verification system of surface-based parameters to track the accuracy of both the numerical model guidance and the official, forecaster-edited grids. One possibility is the development of the Daily Forecast Critique could be accelerated in order to help facilitate this requirement.
- Send to all WFOs the NCEP model data in gridded form at their native resolution in the horizontal and with sufficient low-level vertical extent and resolution to meet new forecast demands (e.g., Smart Initialization, ventilation indices, and others). Research into grid compression for file transfer should continue in order to facilitate these additional data.
- Research, develop, and implement statistical methods to objectively produce bias-corrected model grids for WFO use. These could come from a MOS-like application to model grids, ideally at full grid resolution; not just forecast-point MOS spread across an entire grid. The NWS should take full advantage of resources within and outside of the NWS for this effort.
- Research, develop, and implement methods to objectively downscale forecast grids to the resolution necessary to match the IFPS grids.
- Develop and implement climatology grids for use in GFE. Some of this work has already begun at the Region and local levels with the use of PRISM data, and work such as this should broaden into a national level program.
- Deliver to WFOs the NCEP short- and long-range ensemble mean and spread data in gridded form.
- Modify the GFE software to ingest real-time data such as satellite, radar, and surface observations. The ingest and display of ADAS data in the Western Region has been an important first step in this direction.
- The NWS should strategically consider ways to tap forecaster expertise in the interpretation of model and grid output for possible service and product enhancements of the future (e.g., probabilistic extended-term forecasts and other value-added products).

PROGRAM AND ISSUE BACKGROUND: The need to modernize end-user products has been discussed since the mid 1980s when the idea of having forecasters manually-edit graphical and gridded forecasts was first defined. Much has transpired since this idea was developed and, in light of more than a decade of advances, a re-evaluation is absolutely necessary. We must determine what assets are required to successfully produce skillful gridded forecasts, along with identifying the optimal use of the human forecaster in a gridded forecast era.

The NWS implementation plan currently endorses the paradigm that forecast products will be derived directly from the multi-dimensional gridded forecast. In addition, user-derived forecasts

will be objectively extracted from these grids, based on individual user needs and requirements. Due to areas of complex terrain and implied “point-precision” accuracy, this paradigm requires the grids be delivered at a very high resolution (~2-5 km) throughout the forecast period (currently 7 days). Unfortunately, this relatively simple and appealing paradigm places significant demands on the operational environment if these grids are to be as accurate as possible, as well as detailed.

The use of a single high-resolution detailed forecast through seven days is in opposition to current scientific sentiment (as expressed by the AMS statement “Enhancing Weather Information with Probability Forecasts,” adopted by the AMS Council on 13 January 2002, http://www.ametsoc.org/AMS/policy/enhancingwxprob_final.html) and severely limits the way probabilistic and confidence information can be communicated. NCEP has been aggressive in pursuing probability forecasts and has an operational, medium-range ensemble forecast system that could prove useful to the field, but these data are not currently available within the AWIPS/IFPS data stream. Operational models from other institutions (e.g., the ECMWF) would also be useful in IFPS/GFE if available. For example, they would help define forecast uncertainty and aid forecasters in composing a non-GFS forecast in the medium range without excessive hand editing.

The Satellite Broadcast Network’s (SBN) operational data stream is designed to meet the lower-resolution requirements of text product generation. For example, even though operational forecast models are running at higher and higher resolution (grid spacings now down to 12 km), the highest resolution grids distributed via the SBN and viewable in AWIPS, are generally at 40 km grid spacing or coarser. This has been acceptable since there is little impact on text forecast quality due to the fundamental inability to communicate detail via worded forecasts (i.e., the “broad brush” of text products).

With the new paradigm of gridded forecasts, data stream requirements are dramatically different. Field forecasters are now asked to create forecasts on grids of 5 km or less – resolutions that are actually higher than the current operational models. Yet, the current SBN data stream degrades model data over its actual native resolution. This forces the forecaster to add back mesoscale detail and corrections using a variety of often-simple grid-editing tools, rather than improving on the native model grids through local knowledge and experience.

From the onset of the Modernization many assets have gone into programs designed to address short time- and space-scale forecast problems. Yet the realm of the text product has continually hindered the effective communication of this enhanced mesoscale knowledge. The implementation of gridded forecasts also presents new challenges to short-term monitoring and prediction, which are critical human functions in the forecast process. Adjusting short-term grids is complicated by deficiencies in the current IFPS/GFE system that prevent integration of real-time observations with the forecast grids. Currently, observations that cannot be integrated include radar and satellite imagery, METAR and ROSA reports, and mesonet data.

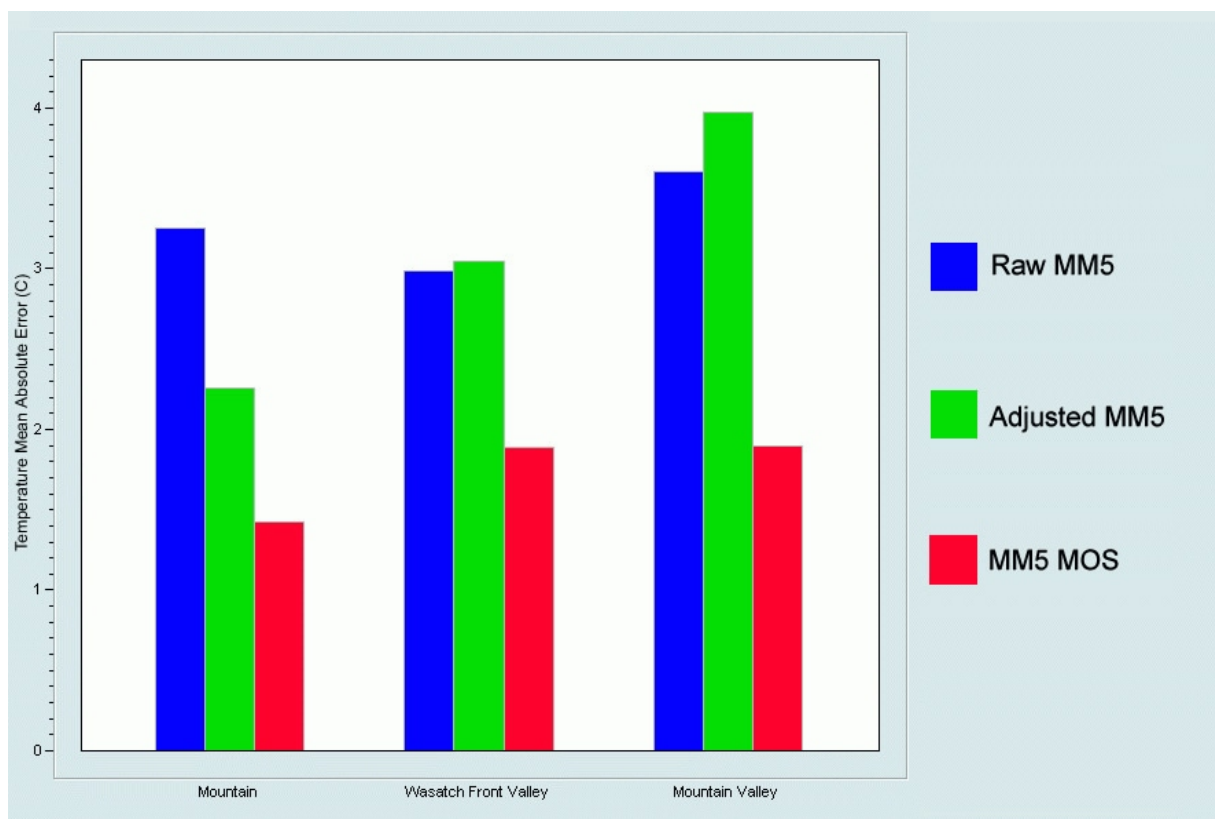
Climatology has always played an important role in the forecast process, in both verification and

calibration. Additionally, it is known that statistical tools trend toward climatology as prediction skill decays. We recognize that some efforts are currently underway to incorporate climatological fields into the IFPS forecast process and simply want to underscore the importance of having these fields available to the forecasters as quickly as possible.

To allow the forecasters to focus on the most effective grid-editing tasks, it is paramount that they be given the absolute best possible first-guess grids. Not only does this require grids at full model resolution, but also sophisticated statistical applications to post-process and remove identifiable model biases. Statistical tools must be derived on a full grid and not be artificially produced by spreading out coarse station-derived MOS across a grid – an approach that will simply not work in areas of complex terrain.

To illustrate the utility of high-density post-processing, Figure 1 compares full resolution (12-km grid spacing) MM5 model forecast errors, MM5 MOS forecast errors, and errors for the MM5 forecast adjusted for differences between modeled and observed terrain (assuming a 6.5 C/km lapse rate, which is a similar approach to that currently used in IFPS “SmartInit”). Given the prevalent cool-season inversion over the western United States, in this case the lapse-rate adjustment technique actually *degrades* the forecast, whereas the MOS approach provides the

Figure 1. Model mean absolute error (MAE, degrees C) of hourly temperature forecasts at 18 sites (2 of which



are METAR sites) used for weather support at the 2002 Olympic Winter Games in Salt Lake City, decomposed for mountain (mid or upper elevation), Wasatch Front valleys, and mountain valleys. Validation period covers late January to late March, 2002. (Courtesy of CIRP, University of Utah).

greatest skill. Although limited in scope, this and similar examples illustrate the need to have

statistically post-processed grids and further brings to light the challenges of adjusting model grids in complex terrain.

Work should begin immediately to develop and implement scientifically sound, down-scaling applications. Such applications are required since, even at full resolution, current NCEP models are too coarse to capture the detail required by current IFPS specifications. It is likely that such development is beyond the scope of the local office and should be addressed through a nationally directed and implemented program that leverages all resources available to the NWS. These resources include the NOAA research laboratories, NWS centers, academic institutions, NWS regional offices and field offices working together.

In business, performance evaluation tools are critical in determining the success of any system, and IFPS should not be an exception to this rule. Yet, at present, there is no objective method for assessing the accuracy of numerical forecasts of sensible weather, or of forecaster edits over an entire grid. In some instances it is possible that, while improving upon the native model forecast in some areas, the forecaster may actually be degrading the forecast in other areas. A comprehensive gridded verification system is urgently needed so that forecasters and management can best assess where the human forecaster can add value to the model grids. This system should be available to WFO's for real-time use to allow forecasters to learn from their previous gridded forecasts on a daily basis. Western Region SSD and FSL have already begun to develop verification systems and these efforts should continue to be accelerated and expanded.

The National Weather Service forecasters have always been valued and recognized by their constituents as the local experts who provide reliable, knowledgeable information through a strong customer outreach and service program. All efforts must be made to protect and avoid disrupting this unique, interpretive, and "beyond-the-models (or grids)," value-added information that reflects upon the local forecasting expertise and professionalism of our field staff.

SUMMARY: IFPS lifts the NWS beyond the single dimension and crude resolution of simple worded forecasts, providing customers the opportunity to extract detailed, location-specific forecast information in diverse forms. Inherent to this product shift comes an increased responsibility for accuracy as customers trust, scrutinize, and make critical decisions based on high-resolution gridded NWS forecasts. As the system is currently designed, attaining this accuracy while maintaining excellence elsewhere in the program presents significant challenges for NWS field office forecasters. There is serious concern that the current path - one that does not take full advantage of advances in technology and the forecast process - will be detrimental to the effectiveness of IFPS, and ultimately threatens the success of the NWS.

This position paper presents a set of proposals designed to improve the digital forecast process. If implemented, these proposals will establish an end-to-end effort capable of providing detailed and *accurate* digital forecasts to our customers and partners without sacrificing other mission critical services. This successful effort includes forecasters serving as local interpretive experts who will continue to provide a quality of service that keeps the NWS at the forefront of weather forecasting.